WSRC 14-35
Rev 10-88

SAVANNAH RIVER
DOCUMENT APPROVAL SHEET
(See SRP Procedures Manual Item 101)

Document Number WSRC-RP-89-467
UC or C Number 705

1. DESCRIPTION OF DOCUMENT (to be completed by author)

TITLE TRAINING MANAGEMENT INFORMATION SYSTEM

AUTHOR(S) MARK P. RACKLEY PHONE NO. 7-9333

TYPE: ☐ INTERNAL DOCUMENT ☐ EXTERNAL DOCUMENT
☐ DP Report
☒ Paper (see below)
☐ Other

Additional Information for External Papers

PAPER FOR: Presentation Only _____ Publication Only _____ Both XXX

MEETING NAME WESTINGHOUSE COMPUTER SYMPOSIUM

CITY PITTSBURGH, PA DATES NOVEMBER 6-7, 1989

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CLASSIFICATION (circle one for each)

Overall	S	C	UCNI	U
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CLASSIFICATION GUIDE TOPICS
SR-IC-50
Topic 763

PATENT CONSIDERATIONS
Possible Novel Features NA
Closest Prior Art

APPROVED BY AED PATENT & CLASSIFICATION OFFICER C. J. Fonnesbeck DATE 8/1/89

4. PUBLICATIONS DIVISION PROCESSING

DATE RECEIVED _____ PUBLICATIONS SUPERVISOR _____

EDITOR P. E. Miller (8/1/89 @ 2:20P.M.) DATE ASSIGNED _____

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DOE-SR RELEASE DATES: Patent Branch _____ Tech. Info. Office 8/17/89

DATE COMPLETED _____ DATE SUBMITTED TO OSTI 9/06/89

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675378

Westinghouse
Savannah River Company

P.O. Box 616
Aiken, SC 29802

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August 1, 1989

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WSRC-RP-89-467, "TRAINING MANAGEMENT INFORMATION SYSTEM," M. P. Rackley.

A paper proposed for presentation and publication at the Westinghouse Computer Symposium in Pittsburgh, PA on November 6-7, 1989.

Technical questions pertaining to the contents of this document should be addressed to the author(s) or

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OSR 25-82-W(4-89)

DOE F 1332.15 (5-88)

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1. DOE Report No.	2. DOE Contract No.	3. DOE B and R code(s)	4. OSTI UC or C Category No.
WSRC-RP-89-467	DE-AC09-88SR18035		705

5. Title
"TRAINING MANAGEMENT INFORMATION SYSTEM", MP RACKLEY

6. Type of Document ("x" one)

a. Scientific and technical report: ☐ monthly ☐ quarterly ☐ annual ☐ final ☐ topical ☐ other

b. Conference paper: Name of conference (no abbreviations)
1989 WESTINGHOUSE COMPUTER SYMPOSIUM

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Date (mo/day/yr) ~~NOVEMBER 6-7, 1989~~ Sponsor

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TRAINING MANAGEMENT INFORMATION SYSTEM*

By

Mark P. Rackley

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

A paper proposed for presentation and publication
1989 Westinghouse Computer Symposium
Pittsburgh, PA 15230-2728
November 6-7, 1989

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*This paper was prepared in connection with work done under Contract No. DE-AC09-76SR00001 (now Contract No. DE-AC09-88SR18035) with the U.S. Department of Energy.

Training Management Information System

(TMIS)

by

Mark P. Rackley

Westinghouse Savannah River Company

Savannah River Site

Drawer A

Aiken, SC 29808

803-557-9333

Abstract

The Training Management Information System (TMIS) is an integrated information system for all training related activities. TMIS is at the leading edge of training information systems used in the nuclear industry. The database contains all the necessary records to confirm the department's adherence to accreditation criteria and houses all test questions, student records and information needed to evaluate the training process. The key to the TMIS system is that the impact of any change (i.e. procedure change, new equipment, safety incident in the commercial nuclear industry, etc.) can be tracked throughout the training process. This ensures the best training can be performed that meets the needs of the employees. TMIS is comprised of six functional areas: Job and Task Analysis, Training Materials Design and Development, Exam Management, Student Records/ Scheduling, Evaluation, and Commitment Tracking. The system consists of a VAX 6320 Cluster with IBM and MacIntosh computers tied into an ethernet with the VAX. Other peripherals are also tied into the system: Exam Generation Stations to include mark sense readers for test grading, Production PC's for Desk-Top Publishing of Training Material, and PC Image Workstations.

BACKGROUND

The Training Management Information System (TMIS) is an information system designed to track the training processes at the Savannah River Site. The Savannah River Site is operated by Westinghouse Savannah River Company for the Department of Energy (DOE) for the production of nuclear materials. The DOE has adopted the Systematic Approach to Training (SAT) Process. The DOE is also adopting an accreditation process similar to that of the process established by the Institute of Nuclear Power Operations (INPO) for commercial nuclear power facilities. To maintain an auditable trail of the training process, most nuclear facilities have some form of database or information system. TMIS is one of the few systems that is integrated over all activities of the training group. Some commercial plants have exam bank systems to generate tests, a database to generate a task to training matrix, a test grading and analysis program to evaluate the written tests and record student grades, or a student record and scheduling program. Some commercial plants have systems that do all of these and in addition provide a word processing and desk-top publishing capability that utilizes the task statements and learning objectives already generated in the analysis and design phases of the training process. TMIS is the first integrated Training Management System developed for a network to provide information to both Training Department and Operations Department Management.

TMIS has been developed in two stages. Most of the functions previously mentioned are in the foundational system in place now. Specialized report generation will be incorporated in the enhanced system during 1990. One of the strong points of the foundational TMIS system is Commitment Tracking to ensure the information stored within TMIS stays current. The commercial nuclear industry as a whole is a young industry. Savannah River Site (SRS) is nearing forty years of safe operation. Concern for maintaining the facilities current with modern technology requires a great deal of modifications each year to our facilities. Many of these modifications require training. In addition, the nuclear industry as a whole is under the careful eye of the general populace. Incidents throughout the nuclear industry and similar media intensive industries, such as the space program, need to be studied for their applicability to operations at SRS. Where many utilities have performed a "one-time" job and task analysis to base their training program upon, Commitment Tracking within the TMIS helps to ensure this analysis remains current. Thus the data stored within TMIS becomes a snapshot of where we are now within our training programs, not where we were when we performed our initial analysis. TMIS also provides complete historical information that documents how we got to where we are.

SCOPE OF TMIS SUPPORT

TMIS, as it now resides on the VAX computer, contains the data for all Reactor Training Programs. The programming has been done such that any training group can adapt the jobs within its organization to the structure established in TMIS. Presently the data for five training programs reside within TMIS: Reactor Operations - Center Section, Components Handling Operations, Reactor Maintenance, Reactor Technical Staff and Management, and Instructor Training.

The relative size of the TMIS modules is shown of Figure 1. Table 1 shows the major functions contained in the modules.

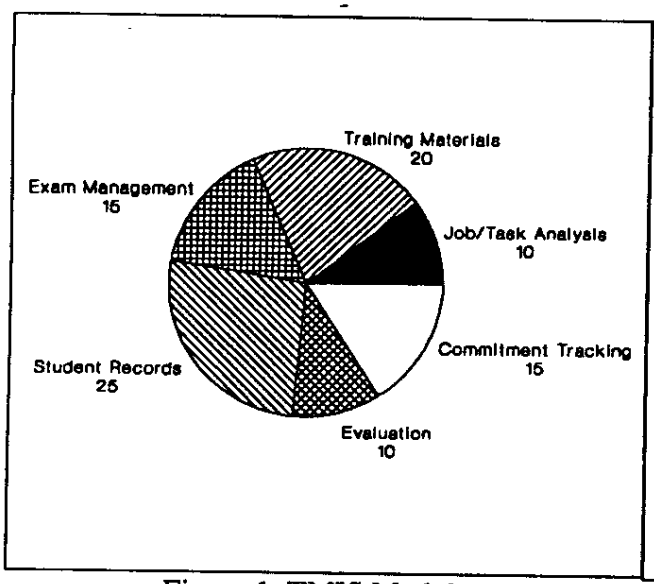

Figure 1, TMIS Modules

Job Analysis
Task Analysis
Writing Objectives
Writing Exam Questions
Producing Training Materials
Scheduling Training
Generating Exams (with Graphics)
Grading Exams (with Scanner)
Training Attendance/Completion
Exam Item Analysis
Qualification Matrix
Certification Records
Student Feedback/Evaluation
Commitment Tracking
Management Tools

Table 1, List of TMIS's Major Functions

SAT PROCESS

To describe what data is contained within TMIS a review of the SAT process is necessary. This process is similar to the Training System Development (TSD) of INPO or the military's Instructional System Development (ISD). As shown in Figure 2, the SAT process in comprised of five phases: Analysis, Design, Development, Implementation, and Evaluation. Figure 1 also shows the TMIS modules and how they mesh with the SAT process. The SAT process is not as linear as the drawing indicates. There is overlap and feedback at every step of the process.

The Analysis Phase is where data is collected on what jobs are performed, what tasks comprise a job and which of those tasks require training (Job Analysis). Also part of the Analysis Phase is data collected on those tasks and organizing the skill and knowledge measures required to properly perform the tasks into taxonomies.(Task Analysis) The Design Phase is where learning objectives and exam questions are generated. From the types of learning objectives, the training designer determines the most appropriate method for delivering the training. The Development Phase is where the training materials, such as the lesson plan and study guides, are developed. The materials for demonstrations and laboratory exercises are also designed and produced in this phase. The Implementation Phase is where the training is conducted. The Evaluation Phase is where the effectiveness of the training is determined and corrective action is fed back into the appropriate phase(s) of the process. The evaluation phase really occurs throughout the other phases. For example, when developing a lesson plan for a particular learning objective, a

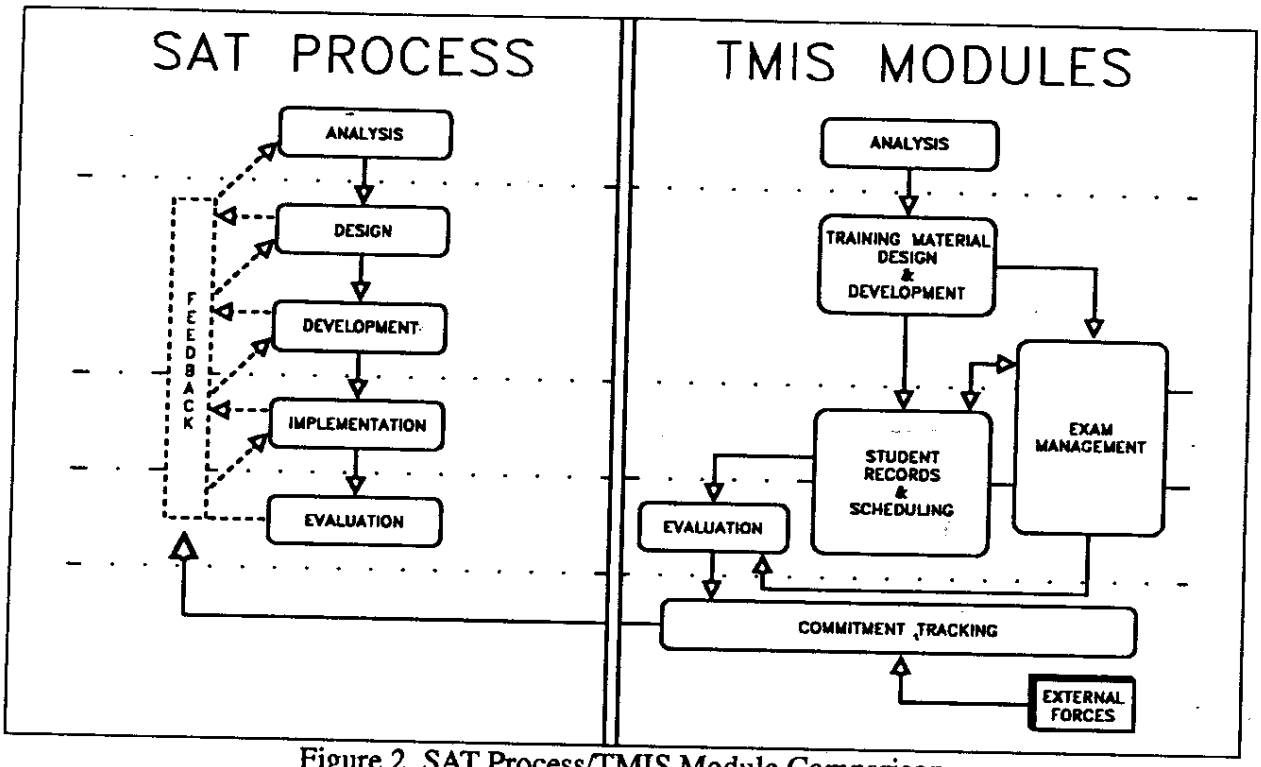

Figure 2, SAT Process/TMIS Module Comparison

developer discovers the objective cannot be adequately covered without a laboratory exercise. The design phase would then be revisited to ensure the proper course structure is produced.

ANALYSIS

In the Analysis Phase two major processes are performed. Job Analysis is the process where a job is defined and all tasks associated with that job are analyzed. The analysis of each task produces the relative Difficulty, Importance, and Frequency (DIF) of each task. The DIFs are determined by a group of Subject Matter Experts (SMEs) from the group which will eventually receive the training. Using a decision tree similar to the one in Figure 3, the analyst can determine whether each task should be trained, not trained, or "over-trained." Over-trained tasks are those that are placed in continuing training and employees receive training in those areas every two years. Trained tasks are placed in initial training, but will normally not be re-trained at a later date. The tasks are input into TMIS where the training decision is calculated automatically using the decision tree. If the user group, training group, or training manager disagree, comments as to their reasons are required. The training manager has the final decision on which tasks are trained. Table 2 shows the volume of information required for the TMIS system.

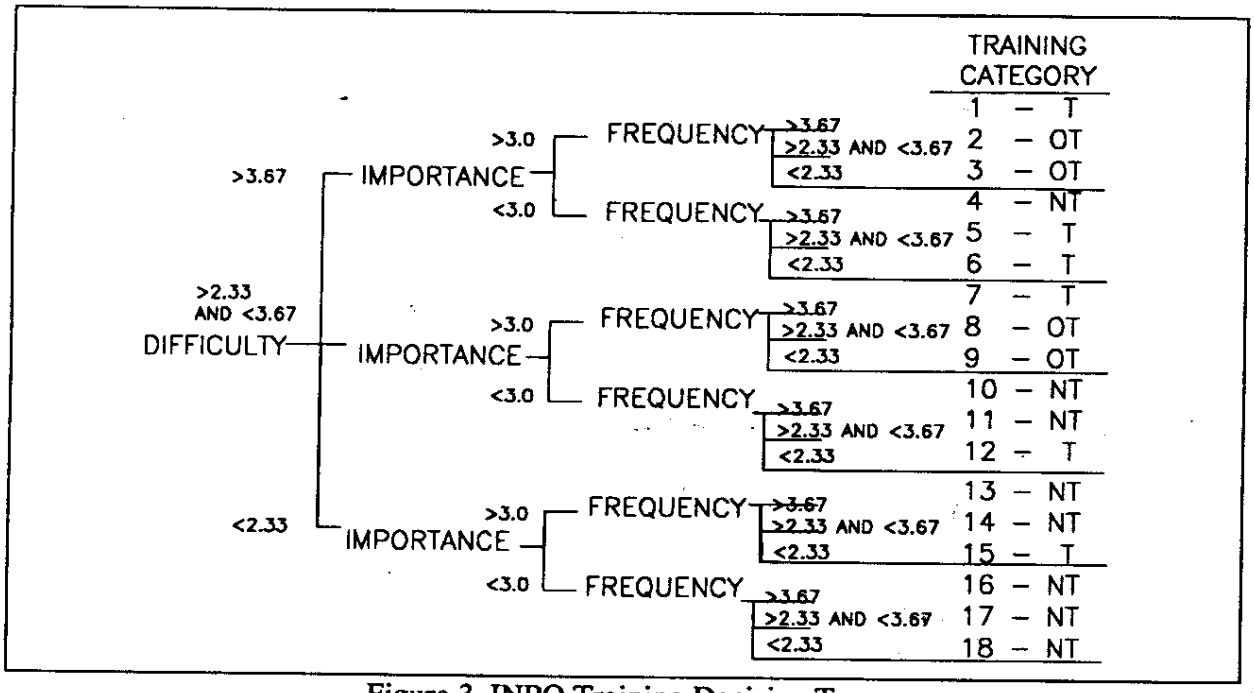

Figure 3, INPO Training Decision Tree

Task Analysis is performed on only the tasks selected for training. Task Analysis is a detailed view of the tasks including the steps in performing the task (task elements), the initiating and terminating cues, skills required to perform the task elements, knowledge required to perform the task elements, the conditions in which the task must be performed, and the standards the worker must achieve to determine that he has successfully completed the task. The analyst works with the SME to determine this information and inputs the information into TMIS. The task and task elements are also linked to other data stores such as, Source (Procedure), Tools, Equipment, References, and Materials. These data stores are different for each training program. The entity relationship diagram in Figure 4 shows the relationships between the data within the Analysis Module.

As many as 100 Tables
Approximately 7,000 Tasks
Approximately 2,000 Courses
Up to 100,000 Objectives
Approximately 200,000 Exam Questions
2,000 Students within Reactor Areas
Additional 3,000 SRS Personnel (receiving training)

Table 2, Sizing Requirements of the TMIS Database

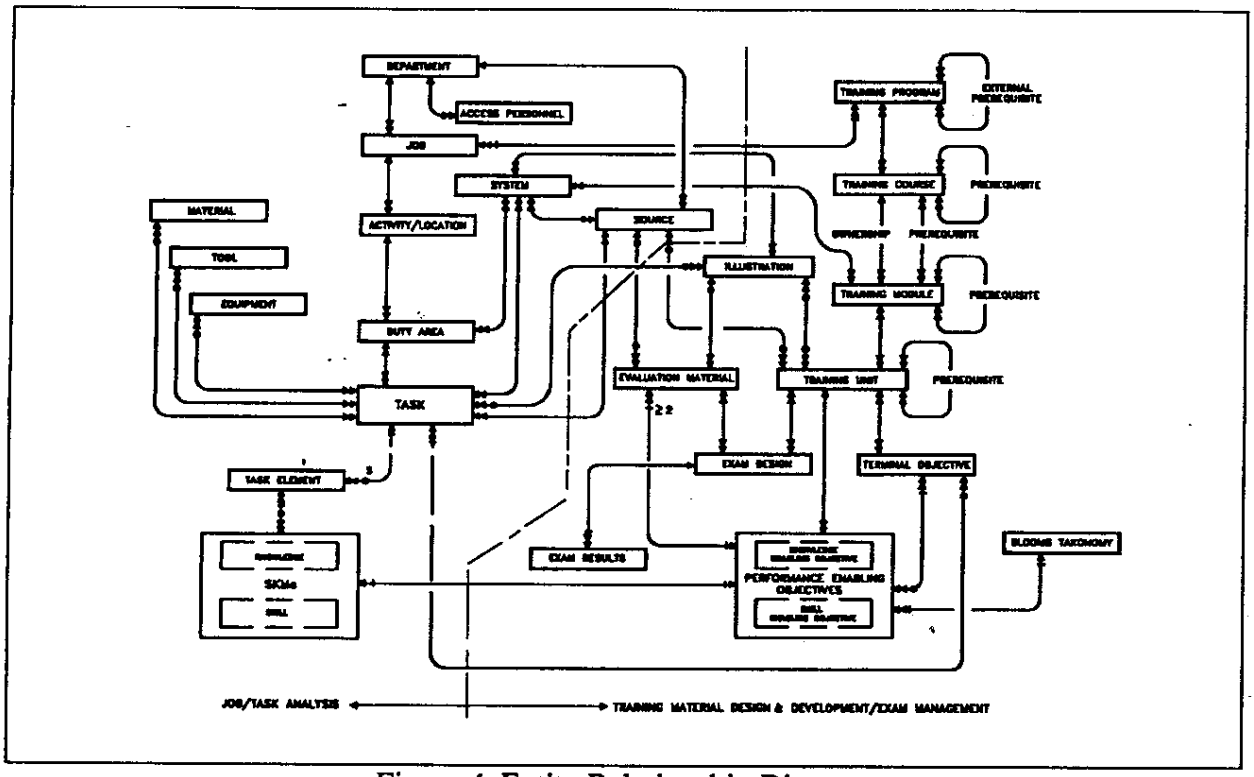

Figure 4, Entity Relationship Diagram

TRAINING MATERIAL DESIGN AND DEVELOPMENT (TMDD)

The Design Phase is characterized by the production of learning objectives and evaluation material. All of the typing of this material is performed on the VAX. Terminal Learning Objectives are tied directly to tasks that have been selected for training. Some terminal objectives are linked to knowledge measures, not to tasks, for academic courses. For example, it is difficult to "DO" Thermodynamics. Enabling objectives are written for each skill and knowledge measure identified in Task Analysis. Enabling Objectives are grouped together to support the Terminal Objectives.. Once the objectives have been written, a determination is made by the training designer as to the best method to present the material using the objective statement as his guide. Thus the training material structure and eventually the curriculum are produced from training material design. The learning objectives then become the foundation of the training material that follows. No test questions are written unless they are based directly upon a learning objective. There must be a minimum of two questions per objective due to a site guideline of a maximum of 25% repeat question from one test to the next. Evaluation material other than written test items are written either during design or development. TMIS will not allow computer work to continue on training material unless the objectives and evaluation material (within each setting for a given course) are developed and approved. It would be counter-productive to begin working on training material based upon teaching a specific learning objective when that learning objective could be changed.

In TMIS, the design phase is maintained within TMDD. Data stores include Terminal Objectives, Enabling Objectives, Evaluation Material, Training Material Structure, and thus Training Program Structure. TMIS then shifts into PC mode for the Development Phase. The development phase is predominately desk-top publishing, Ventura, and is disc storage intensive due to the tremendous number of illustrations required. The TMIS system shifts transparently (to the operator) from VAX processing mode to PC control for desk-top publishing, word processing, and transferring illustrations to storage. To ensure the least amount of duplicated effort, an illustration log is maintained by the illustrators of the production group. A developer can review the log to see if the drawing needed for his training material is available. It could be that only minor modifications of an existing drawing are required. This ensures up-to-date accuracy of the illustrations as well. Figure 4 is also entity relationship diagram for the information in the TMDD module.

EXAM MANAGEMENT

The Exam Management module of TMIS is the integration of a product produced by QUALTEC, Inc. with TMIS. The QUALTEC system generates written tests from the exam bank provided by TMIS. Specifications on the make-up of the exam are put into the MacIntosh based QUALTEC system. The exam is generated on the MAC. The VAX then takes over to ensure the 25% repeat question rule and then the MAC prints the exam and answer key. The strong points of this system are that questions for a given test specification can be shuffled, the multiple choice answers for a given question can be shuffled, and the enhanced capabilities of the Macintosh graphics are incorporated. The Macintosh system is equipped with tape back-up, laser writers, and mark sense readers for automatic grading of exams. The tests are generated such that essay and short answer questions are placed after multiple choice, true-false, and matching questions. The student uses the mark sense card until he reaches the questions requiring written response. The instructor then grades the actual test paper and marks the mark sense card for the percentage credit the student received for each essay and short answer question.

The Exam Management module is shown on Figure 1 covering portions of Design, Development, Implementation, and Evaluation Phases of the SAT process. Exam question generation is performed in the Design Phase. Illustrations are developed in the development phase. The exam management system requires test specifications in the Implementation Phase prior to generating the examinations. The results of those tests then becomes part of the Evaluation Phase. First the students are evaluated to determine whether they have met at least the minimum proficiency required. The results of the examinations are then analyzed to determine their effectiveness. Exam item validity can be checked using the Exam Management module. The Evaluation Module will be expanded during 1990 as part of the enhanced TMIS system.

STUDENT RECORDS AND SCHEDULING

The Student Records and Scheduling Module tracks the Implementation Phase of the SAT process. The student records are a major source of data for the Evaluation Phase and include the primary data stores for the Evaluation Module of TMIS. Student Records contains information on the students from several aspects. First, the student information will give a detailed background on education and past courses, such as site sponsored courses, military training, and tech school. The employee's employment and site work experience is recorded. The employee's current work assignment is then compared to the training requirements for that position. All courses that the employee needs to perform his or her job are scheduled if there is not a record of successful completion. The employee's performance in each course is also recorded. The instructor has an opportunity to input subjective comments about the students along with their grades. This is useful in considering upgrades to instructor positions for those who have a good attitude about training and are helpful in class or are assisting line-management in identifying problems that are not suited for training.

Scheduling, like Student Records is, multi-faceted. The needs of each student, the available classrooms, the schedule for development of new training material, and available qualified instructors all have to be meshed into a single schedule. The scheduling of classrooms and students for each class has become one of the largest jobs in training. Even beyond classrooms, are there overhead projectors, flip-chart easels, and 35mm projectors available? All continuing training courses for shift personnel are scheduled when the shift rotates onto the training shift. Day personnel have to be scheduled as part of a shift class or separately. Initial training is only conducted while personnel are off of the shift rotation. Once all of these factors have been carefully balanced, management can review training needs and add a third form of training, emergent training. For example, a Three Mile Island, Chernobyl, or Challenger incident occurs and warrants an immediate course developed on lessons learned. This course then bumps other courses further back into the schedule and triggers the need for analysts to determine the appropriate place for the material in the permanent training program. The schedule is produced by TMIS with enough input from the training managers to prevent TMIS from trying to create an impossible schedule.

EVALUATION

The Evaluation Module will not be completed until 1990. The concepts within the module are to track each individual from pre-class evaluation to post-post-training evaluation. The student can be evaluated prior to beginning training. The student will receive evaluation during and at the end of each training session (post-evaluation). Post-post-evaluation will occur at least one month later by several means: evaluators viewing work performance in the field, supervisors reporting work changes in work performance after the course, and written examinations to test retention of classroom material.

COMMITMENT TRACKING

The Commitment Tracking Module closes the loop on the SAT process. The module formalizes the feedback loop of the SAT process. It also provides a means for anyone outside the normal development of the training program to have input into improvements in the training program. Periodic reviews are made of the INPO nuclear network, DOE nuclear network, and other sources of unusual incident reports. DOE, Congressional Sub-Committees, INPO, and other organizations (i.e. National Academy of Sciences) have audited training and had comments that had an impact on the training program. Plant Modifications, Procedure Revisions, and Management Directives have also caused changes in existing training material. All of these factors and more can cause shanges to occur in what is presented to the students. To ensure that what we teach is current and accurate, commitment tracking provides two services. Commitment tracking identifies through keyword search and direct links a list of possible affected training material from task analysis to lesson plans. In addition, commitment tracking identifies a key individual as the responsible person for investigating the need to change the training program. That person in turn can close out the commitment or assign action plans to make the necessary changes. The Commitment Tracking Manager oversees the entire process. Deadlines are assigned and the commitments are tracked, including time spent working toward closure of a commitment. Commitments do not have to be training related. The Commitment Tracking module is designed to serve as a reminder to any user for commitments as large as developing a new training program to remembering to send out Christmas Party invitations.

TMIS EQUIPMENT

TMIS resides on a VAX 6330. Everyone in the training group has access to the VAX via ethernet. Figure 5 shows the ties into the VAX network. Other VAX systems connected to the ethernet are used for electronic mail and other applications, such as a procedures system. The site has a site license for PCLink software to emulate VAX terminals whether the computer is a MAC, IBM, or clone. The software is different for each keyboard configuration. One factor that hampers the system is that the VAX emulation ignores the mouse. All pull-down menus are selected by first letter entry or the arrow keys.

The software vehicle for the information system is Oracle. Oracle SQL*Forms provides pull-down menus and pop-up windows. This allows ease of data entry and makes the system more friendly. The system is designed for about 64 simultaneous users and can accomodate over 100. If more users are needed performance would drop. Discussions have started to take place for a plant wide system. The TMIS system would be converted and transfered to the IBM mainframe. Through the PCLink software and ethernet, connections can be made to the mainframe from any PC on the network.

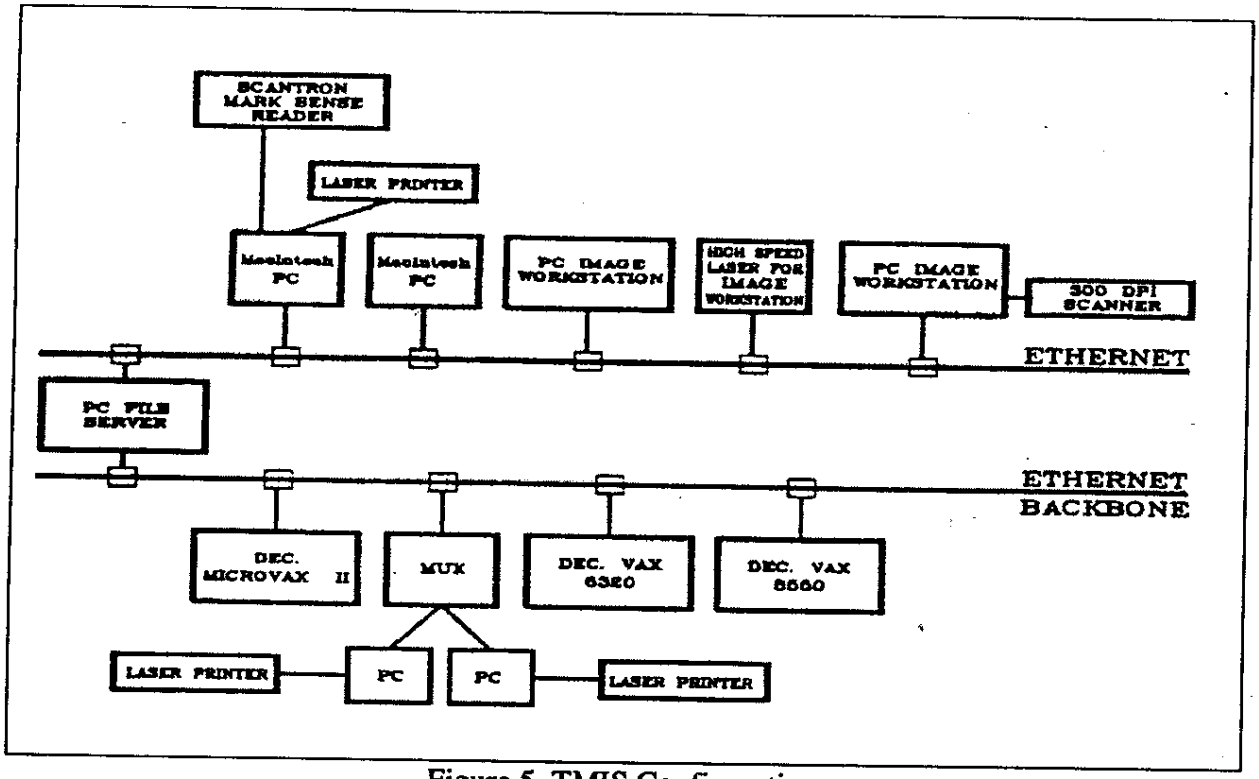

Figure 5, TMIS Configuration

DATABASE ADMINISTRATION

The TMIS group is comprised of a manager and three database administrators. Each of these administrators is responsible for one major training program. The DBAs have primarily computer and information system backgrounds, but concentrating on a specific training program they can develop an expertise on the terminology associated with that program. Without a working knowledge of the jargon, keeping the data clean would be impossible. The DBAs establish user group review committees to review data that has been updated. This keep the communication lines open and prevents the training group from abandoning the system and allowing the data to get out of date.

Each of the DBAs has additional duties. One DBA is responsible for future programming for TMIS. One DBA is also responsible for maintaining the PC hardware and software within the training group. The third DBA maintains a log of problems and solutions to reduce future downtime and maintains TMIS procedures.